NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

WASTE TREATMENT LAGOON

(No.)

Code 359

DEFINITION

A waste treatment impoundment made by constructing an embankment and/or excavating a pit or dugout.

PURPOSE

To biologically treat waste, such as manure and wastewater, and thereby reduce pollution potential by serving as a treatment component of a waste management system.

CONDITIONS WHERE PRACTICE APPLIES

- Where the lagoon is a component of a planned agricultural waste management system.
- Where treatment is needed for organic wastes generated by agricultural production or processing.
- On any site where the lagoon can be constructed, operated and maintained without polluting air or water resources.
- To lagoons utilizing embankments with an effective height of 35 feet or less where damage resulting from failure would be limited to damage of farm buildings, agricultural land, or township and country roads.

This standard does not apply to Natural Resources Conservation Service (NRCS) Field Office Technical Guide (FOTG) Standard (313) Waste Storage Facility. This standard does not apply to human waste storage.

CRITERIA

General Criteria for All Lagoons

Laws and Regulations. All waste treatment lagoons shall be planned, designed, and constructed to comply with all federal, state and local laws, rules and regulations.

Location. To minimize the potential for contamination of streams, waste treatment lagoons should be located outside of floodplains. However, if site restrictions require location within a floodplain, they shall be protected from inundation or damage from a 100-year flood event.

Waste treatment lagoons shall not be constructed in the 100-year floodway unless permitted by the Indiana Department of Natural Resources (IDNR), Division of Water.

Lagoons shall be located so the potential impacts from breach of embankment, accidental release, and liner failure are minimized; and separation distances are such that prevailing winds and landscape elements such as building arrangement, landforms, and vegetation minimize odors and protect aesthetic values.

Lagoons should be located so they have as little drainage area as possible. If a lagoon has a drainage area, the volume of normal runoff during the treatment period and 25-year, 24-hour storm event runoff shall be included in the required volume of the lagoon.

Access to all manure management systems shall be constructed two feet above the 100-year flood elevation.

Waste treatment lagoons shall not be located in karst terrain or over mines without a detailed geologic exploration and specific design considerations for these sites. Minimum setback distances from other physical features are given in Table 1.

Table 1. Setback Distances

Features (known and identifiable at the time of application)	Minimum Setback Distance (feet)
Public Water Supply and Surface Intake Structure	1000
Surface Waters of the State and Drainage Inlets (including Water and Sediment Control Basins)	300
Sinkholes (measured from the Superficial opening or lowest point)	300
Water Wells (offsite)	300
Water Wells (onsite)	100
Property Lines and Public Roads	100

Soil and Foundation. The lagoon shall be located in soils with an acceptable permeability that meets all applicable regulations, or the lagoon shall be lined. Information and guidance on controlling seepage from waste impoundments can be found in the Agricultural Waste Management Field Handbook (AWMFH), Appendix 10D.

A geologic exploration shall be conducted for all waste treatment lagoons. The exploration must be intensive enough to adequately characterize the site. A minimum of two holes shall be explored. Additional holes may be necessary based on the site size and complexity. The exploration shall extend below the lowest planned elevation of the facility. It shall extend ten feet below for soils in karst topography and five feet below for all others. The exploration shall document the presence or absence of a seasonal high water table. A soils log identifying the soils using the Unified Soil Classification System and showing the location of the seasonal high water table shall be on the plans. Soil sampling shall follow guidance in National Engineering Manual IN531-2.

The soil foundation shall have a maximum specific discharge of 1/16 $in^3/in^2/day$ ($1.8x10^{-6}$ $cm^3/cm^2/sec$) or the lagoon shall be lined.

If soil testing shows that *in situ* soils meet the maximum specific discharge criteria, the existing soils shall be over-excavated a minimum of six inches and recompacted to break up the existing macropore structure. If a clay liner is used, it shall have a maximum specific discharge of 1/16 $in^3/in^2/day$ ($1.8x10^{-6}$ $cm^3/cm^2/sec$). Clay liners shall be a minimum of one foot thick. Bentonite, soil dispersant salts, and impermeable membranes shall be designed and installed in accordance with NRCS FOTG Standard (521 A-C) Pond Sealing or Lining.

The lagoon shall have a bottom elevation that is a minimum of 2 feet above the seasonal high water table unless features of special design are incorporated that address buoyant forces, lagoon seepage rates and non-encroachment of the water table by contaminants. The water table may be lowered by use of perimeter drains, if feasible, to meet this requirement.

Flexible Membranes. Flexible membrane liners shall meet or exceed the requirements of flexible membrane linings specified in NRCS FOTG Standard (521A) Pond Sealing or Lining, Flexible Membrane.

Required Volume. The lagoon shall have the capability of storing the following volumes:

- Volume of accumulated sludge for the period between sludge removal events;
- Minimum treatment volume (anaerobic lagoons only);
- Volume of manure, wastewater, and other wastes accumulated during the treatment period;

- Normal precipitation less evaporation on the surface area (at the design storage volume level) of the lagoon during the storage period;
- Normal runoff from the facility's drainage area during the storage period.
- An additional two feet of freeboard over the above totals.

A minimum of 5 years of sludge shall be designed into the lagoon. Longer periods of 10 years or more shall be considered if space for lagoon construction is available.

The AWMFH gives guidance in computing volumes.

Treatment Period. The treatment is the detention time between drawdown events. It shall be the greater of either 60 days; or the time required to provide the storage that allows environmentally safe utilization of waste considering the climate, crops, soil, and equipment requirements.

Waste Loading. Daily waste loading shall be based on the maximum daily loading considering all waste sources that will be treated by the lagoon. Reliable local information or laboratory test data should be used if available. If local information is not available, Chapter 4 of the AWMFH shall be used for estimating waste loading.

Embankments. The minimum elevation of the top of the settled embankment shall be 2 feet above lagoon's required volume. If a liner is not used, a cutoff of impermeable soil shall be provided at or just upstream of the embankment centerline. The cutoff shall be deep enough to intercept shallow, pervious foundation strata, have a minimum bottom width of 8 feet, and have side slopes not steeper than 1.5:1. The minimum depth of the cutoff shall be 2 feet after stripping.

This height shall be increased by the amount needed to ensure that the top elevation will be maintained after settlement. This increase shall not be less than 5 percent. The minimum top widths are shown in Table 2. The combined side slopes of the settled embankment shall not be less than 5 horizontal to 1 vertical, and neither slope shall be steeper than 2.5 horizontal to 1 vertical.

Table 2 – Minimum Top Widths

Total Embankment Height, ft.	Top Width, ft.
15 or less	8
15-20	10
20-25	12
25-30	14
30-35	15

Excavations. Unless supported by a soil investigation, excavated side slopes shall be no steeper than 2.5 horizontal to 1 vertical.

Inlet. Inlets shall be of any permanent type designed to resist corrosion, plugging, freeze damage and ultraviolet ray deterioration while incorporating erosion protection as necessary. Inlets shall be provided with a water-sealed trap and vent, or similar device if there is a potential, based on design configuration, for gases to enter buildings or other confined spaces. Inlet pipes shall meet the requirements of NRCS FOTG Standard (634) Manure Transfer.

Outlet. No outlet shall automatically discharge from the required volume of the lagoon, except an outlet that releases effluent into another lagoon stage or storage pond. Outlets from the required volume shall be designed to resist corrosion and plugging. Outlet pipes shall meet the requirements of NRCS FOTG Standard (634) Manure Transfer. Anti-seep collars shall be provided around all pipes.

Operating Levels. The maximum operating level shall be top of dam elevation minus the 2-foot freeboard. The maximum drawdown level shall be the lagoon level that provides the volume for the required minimum treatment plus the accumulated sludge between sludge removal events. A permanent marker shall be installed at these elevations.

Facility for Drawdown. Measures that facilitate safe drawdown of the liquid level in the lagoon shall be provided. Access areas and ramps used to withdraw waste shall have slopes that are 10

horizontal to 1 vertical or flatter. Steeper slopes may be used if special traction surfaces are provided or if the ramp will only be used as an access point for pumping equipment. All access areas shall facilitate a safe operating environment. Docks, wells, pumping platforms, retaining walls, etc. shall permit drawdown without causing erosion or damage to liners.

Sludge Removal. Provisions shall be made for periodic removal of accumulated sludge to preserve the treatment capacity of the lagoon. The method for doing this shall not damage the liner.

Erosion Protection. Embankments and disturbed areas surrounding the lagoon shall be protected to control erosion. This area includes the inside slopes of the lagoon as needed to protect the integrity of the liner.

Safety. The design shall include appropriate safety features to minimize the hazards of the lagoon. The lagoon shall be fenced around the perimeter and warning signs posted to prevent children and others from using it for other than its intended purpose.

Seeding. Seeding shall meet or exceed the criteria in NRCS FOTG Standard (342) Critical Area Planting.

Additional Criteria for Anaerobic Lagoons

Loading Rate. Anaerobic lagoons shall be designed to have a minimum treatment volume based on Volatile Solids (VS) loading per unit of volume. The maximum loading rate shall be as indicated in AWMFH Figure 10-22 (Anaerobic lagoon loading rate) or according to state regulatory requirements, whichever is more stringent.

Depth Requirements. The minimum depth at maximum drawdown shall be 6 feet. The maximum depth shall be dictated by the site and equipment.

Additional Criteria for Naturally Aerobic Lagoons

Loading Rate. Naturally aerobic lagoons shall be designed to have a minimum treatment surface area as determined on the basis of daily BOD_5 loading per unit of lagoon surface. The required minimum treatment surface area shall be the surface area at maximum drawdown. The maximum loading rate shall be as indicated by AWMFH Figure 10-25 (Aerobic lagoon loading rate) or according to state regulatory requirements, whichever is more stringent.

Depth Requirements. The minimum depth at maximum drawdown shall be 2 feet. The maximum liquid level shall be 5 feet.

Additional Criteria for Mechanically Aerated Lagoons.

Loading Rate. Mechanically aerated waste treatment lagoons' treatment function shall be designed on the basis of daily BOD_5 loading and aeration equipment manufacturer's performance data for oxygen transfer and mixing. Aeration equipment shall provide as minimum of 1 pound of oxygen for each pound of daily BOD_5 loading.

Operating Levels. The maximum operating level shall be the lagoon level that provides the required lagoon volume and shall not exceed the site and aeration equipment limitations. The proper operating range of the lagoon is below this elevation and above the minimum treatment elevation established by the manufacturer of aeration equipment.

CONSIDERATIONS

General.

Lagoons should be located as close to the source of waste as possible. In addition they should be located considering prevailing winds and landscape elements such as building arrangement, landform, and vegetation to minimize odors and visual resource problems.

Non-polluted runoff should be excluded to the fullest extent possible. The exception is when the storage is advantageous to the operation of the waste management system.

Solid/Liquid separation treatment should be considered between the waste source and the lagoon to reduce loading.

The configuration of the lagoon should be based on the method of sludge removal, site restrictions and method of sealing.

Contact Indiana Department of Environmental Management (IDEM) for the current rules and regulations.

Due consideration should be given to economics, the overall waste management system plan, and safety and health factors.

Considerations for Minimizing the Potential for and Impacts of Sudden Breach of Embankment or Accidental Release from the Required Volume.

Potential Areas for Impact:

- Surface water bodies – perennial streams, lakes, wetlands, and estuaries.
- Critical habitat for threatened and endangered species.
- Riparian areas.
- Farmstead, or other areas of habitation.
- Off-farm property.
- Historical and/or archaeological sites or structures that meet the eligibility criteria for listing in the National Register of Historical Places.

The following should be considered to minimize the potential for accidental release from the required volume when one or more of the potential impact areas may be significantly affected:

- Outlet gate locks or locked housing.
- Secondary containment.
- Alarm system.
- Another means of emptying the required volume.

The following should be considered either singly or in combination to minimize the potential of or the consequences of sudden breach of embankments when one or more of the potential impact areas are affected:

- An auxiliary (emergency) spillway.
- Additional freeboard.
- Storage volume for the wet year rather than normal year precipitation.
- Reinforced embankment – such as, additional top width, flattened and/or armored downstream side slopes.
- Secondary containment.
- Water level indicators or recorders.

Considerations for Minimizing the Potential of Lagoon Liner Seepage.

Consideration should be given to providing an additional measure of safety from lagoon seepage when any of the potential impact categories areas may be affected.

Potential Impact Areas:

- Any underlying aquifer is at a shallow depth and not confined.
- The vadose zone is rock. (Area between the ground surface and water table.)
- The aquifer is a domestic water supply or ecologically vital water supply.
- The site is located in an area of carbonate rock (limestone or dolomite).

Should any of the potential impact areas be affected, consideration should be given to the following:

- A clay liner designed in accordance with the procedures of AWMFH, Appendix 10D with a thickness and coefficient of permeability so that the specific discharge is less than $1.8x\ 10^{-6}$ cm/sec.
- A flexible membrane liner.
- A geosynthetic clay liner (GCL) flexible membrane liner.
- A concrete liner designed in accordance with NRCS FOTG Standard (313) Waste Storage Facility.

Considerations for Improving Air Quality

To reduce emissions of greenhouse gases, ammonia, volatile organic compounds, and odor:

- Reduce the recommended loading rate for anaerobic lagoons to one-half the values given in AWMFH Figure 10-22 (Anaerobic lagoon loading rate).
- Use additional practices in the waste management system.

- Consider using a liquid/solid separation system prior to discharge to lagoon. This will reduce volatile solids (VS) loading resulting in reduced gaseous emissions and odors. Composting of solids will further reduce emissions.
- Design lagoons to be naturally aerobic or to allow mechanical aeration is another consideration.
- Consider covering the lagoon with a suitable cover.
- Consider using an anaerobic digester and biogas capture system.

Adjusting pH below 7 may reduce ammonia emissions from the lagoon but may increase odor when waste is surface applied. See NRCS FOTG Standard (633) Waste Utilization.

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared in accordance with the criteria of this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be developed that is consistent with the purposes of the practice, its intended life, safety requirements, and the criteria for design. The plan shall contain the operational requirements for drawdown and the role of permanent markers. This shall include the requirement that waste be removed from the lagoon and utilized at locations, times, rates, and volume in accordance with the overall waste management system plan. In addition, the plan shall include a strategy for removal and disposition of waste with least environmental damage during the normal treatment period to the extent necessary to insure the lagoon's safe operation. This strategy shall also include the removal of unusual storm events.

Development of an emergency action plan should be considered for lagoons where there is potential for significant impact from breach or accidental release or personal injury. The plan shall include site-specific provisions for emergency actions that will minimize these impacts. This plan shall be posted on the site.

REFERENCES

Indiana Department of Environmental Management (IDEM), Office of Land Quality, "Confined Feeding Control Law"

Indiana Department of Natural Resources (IDNR), Division of Water, "Construction in a Floodway Permit"

USDA-NRCS, Agricultural Waste Management Field Handbook (AWMFH)

USDA-NRCS, National Engineering Manual, Part 531, Geology